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In the heat of the moment: On the effect of state neuroticism on task performance

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## Research Highlights

- We examined the relationship between neuroticism and cognitive performance
- A sample of high-performing professionals was employed
- State neuroticism was curvilinearly related to cognitive performance
- The effect remained unchanged when controlled for trait neuroticism and intelligence
- Experiencing neurotic states can be advantageous when performing cognitive tasks

## Abstract

The aim of this study was to further shed light on the relationship between neuroticism and performance by taking into account the situation-specific experience of neuroticism when undertaking cognitive tasks. A total of 121 high-performing professionals completed a state measure of neuroticism before solving a complex cognitive task. Indicators of trait neuroticism and fluid intelligence were also collected. Analyses revealed a curvilinear effect of state neuroticism on task performance suggesting that moderate levels of neuroticism experienced in a given situation are most effective for cognitive performance. This effect remained unchanged when controlled for trait neuroticism and fluid intelligence. Findings support the importance of better understanding experiential effects of personality on task performance.

Keywords: neuroticism, state, trait, cognitive performance

## In the Heat of the Moment: On the Effect of State Neuroticism on Task Performance

### 1 Introduction

Research on the effect of personality on performance in cognitive tasks has typically been undertaken from a trait perspective. Within this perspective, personality dimensions are conceptualised in terms of structural differences between individuals that are assumed to remain stable across situations and that are related to behaviour, including performance on cognitive tasks (e.g., Ackerman & Heggestad, 1997; Austin, Deary, & Gibson, 1997; Austin, et al., 2002; Reeve, Meyer, & Bonaccio, 2006). In this paper we make a distinction between personality as structure and personality as a state that is experienced in a given situation, and we argue for differences in the structural and experiential effects of personality. Specifically, we focus on one personality dimension, neuroticism, and investigate its effect on task performance, both from a trait and a state perspective.

### 2 Neuroticism and Cognitive Performance

Neuroticism is the Big Five personality dimension that is most closely linked to the experience of negative emotions. Individuals who score high on this dimension are more likely than low scorers to experience negative emotions such as anxiety, depression and anger. They also tend to evaluate themselves more critically (Costa & McCrae, 1992). Such characteristics could be expected to negatively influence performance on cognitive tasks. Indeed, empirical evidence suggests that trait neuroticism is negatively related to cognitive performance; however, the effect is small (Ackerman & Heggestad, 1997; Austin et al, 1997; Reeve et al, 2006). Ackerman

and Heggstad (1997) report a meta-analytic correlation coefficient of  $-.15$  between trait neuroticism and performance in cognitive ability tests.

We discuss two potential reasons for the relatively weak link that has been observed between neuroticism and performance: (1) Contrary to the more or less implicit assumption of linearity (Brand, Egan & Deary, 1994) the neuroticism-performance link might, in fact, not be linear. (2) Trait neuroticism might not be as relevant as state neuroticism for performance on a given task to be performed in a given situation.

### *2.1 The non-linear neuroticism-performance effect*

The argument that neuroticism might be related non-linearly to cognitive performance was proposed as early as the 1960s (Eysenck & White, 1964; Lynn & Gordon, 1961). Using a student sample Lynn and Gordon (1961) observed a negative quadratic effect of trait neuroticism on performance in an intelligence test (Raven's Progressive Matrices). This effect has been explained in terms of drive theory and specifically the Yerkes-Dodson law (Hebb, 1955; Yerkes & Dodson, 1908).

The Yerkes-Dodson law states that (a) performance is an inverted U-function of arousal, such that as arousal increases performance first increases and then declines, and (b) the optimal level of arousal for performance is a function of task difficulty, such that easier tasks require higher levels of arousal than more difficult tasks. If trait neuroticism is identified with arousal or autonomic drive (Eysenck & White, 1964; Lynn & Gordon, 1961), and assuming that tasks in cognitive ability tests like the Raven's Progressive Matrices are of moderate difficulty to most individuals, it follows that both high and low levels of trait neuroticism are less effective than

moderate levels of trait neuroticism in terms of performance on such tasks. Note however, that the Yerkes-Dodson law refers to within-person differences in the subjective experience of arousal when dealing with a cognitive task, which is arguably different from between-person structural differences in neuroticism as typically studied. Whereas differences in arousal can easily be manipulated, for example with varying doses of caffeine (Anderson, 1994), it is typically not expected that structural differences in neuroticism are similarly malleable (McCrae & Costa, 1999).

Possibly as a result of this conceptual issue of equating differences in the experience of arousal with structural differences in neuroticism, empirical evidence for a non-linear neuroticism-performance effect has been limited. Austin et al. (1997) observed a quadratic effect of trait neuroticism on cognitive performance, though, this effect was in the opposite direction with low and high neurotics (assessed using the NEO Five Factor inventory, Costa & McCrae, 1992) performing best on the Raven's Standard Progressive Matrices and a reading test. However, in a later study using a broader set of cognitive tasks, Austin et al. (2002) were unable to replicate this finding. Similarly, other authors found no evidence for a curvilinear relationship between trait neuroticism and cognitive performance (Reeve et al., 2006).

## *2.2 State neuroticism is too general*

As argued, a possible reason for the difficulties authors have had in establishing a common understanding of the nature of the relationship between neuroticism and cognitive performance might be that they have typically analysed this relationship with a trait rather than state perspective. Traits, such as neuroticism,



have been interpreted in terms of enduring neurobiological (Eysenck & Eysenck, 1985; Depue & Collins, 1999), genetically (pre-)determined (Jang, et al., 2001), or complex psychological structures (McCrae & Costa, 1999), which are typically seen as unaffected by situational characteristics. For example, trait neuroticism has been identified with a neural system that relates to sensitivity to punishment (Gray, 1982) that predisposes individuals to higher levels of negative affect across threatening situations. In contrast, personality *states* characterise the momentary cognitive-affective experience of an individual and the related behavioural responses to specific situational cues. Thus, it is the personality state that signals the individual's current level of adaptation to the environment and is the proximal determinant of the individual's behavioural response. For this reason, the state experienced when undertaking a cognitive task might be a better predictor of performance than the related trait.

A state construct that has received much attention in the cognitive testing literature is test-anxiety. Test-anxiety can be interpreted as a state anxiety due to testing conditions (Hembree, 1988). Test-anxiety is related to neuroticism in that it taps into negative emotionality, and there is some evidence suggesting that trait neurotics are more likely to experience test anxiety (Dobson, 2000; Moutafi et al, 2006). Correlations between test-anxiety and cognitive performance tend to be consistently stronger (meta-analytic  $r = -.33$ , Ackerman & Heggestad, 1997) than between trait neuroticism and cognitive performance (meta-analytic  $r = -.15$ ).

The experience of a particular state will have causal properties that are distinct from the effects of the trait structure. There are at least two reasons why we assume

this to be the case: (1) Experiencing a particular state might signal information about the situation. For instance, negative affect might indicate urgency of the situation. This information cannot be inferred from the related, context-free, structural (i.e. trait) components of neuroticism, (2) Experiencing a particular state can have an energising effect on behaviour. State anxiety, for example, has been associated with increases in on-task effort and initiation of processing activities (e.g., strategies) designed to improve performance (Eysenck & Calvo, 1992).

### *2.3 The current study*

To our knowledge, there are few studies that have specifically looked at the effect of state neuroticism on cognitive performance, however there is indirect evidence that suggests that this effect might, in fact, be positive. For instance Beckmann, Wood and Minbashian (2010) demonstrated that, when experiencing anxiety, frustration and stress – i.e., higher states of neuroticism – individuals tended to engage in more conscientious behaviours. To the extent that conscientiousness includes performance-facilitating behaviours, such as effort investment, efficiency, and systematicity, neurotic states might facilitate performance in cognitive tasks. Similarly, negative affect (a major aspect of the neurotic response) has been related to improved performance in tasks that require systematic, detail-oriented, bottom-up processing and the incorporation of new knowledge (Bless & Fiedler, 2006; Forgas, 2008).

We hypothesise that higher levels of state neuroticism will facilitate performance in a cognitive task, up to a certain level. We also expect very high levels of state neuroticism to be detrimental to task performance. In operational terms, we

will test whether state neuroticism is curvilinearly related to performance in cognitive tasks, such that performance at low and high state neuroticism scores is lower than performance at moderate levels of state neuroticism.

To establish that a state perspective on neuroticism provides unique information not captured by the traditional trait perspective we will analyse whether the effect of state neuroticism occurs independently of individual differences in trait neuroticism.

One potential confound of the relationship between neuroticism and cognitive performance might be the level of cognitive ability. For instance, individuals who experience more difficulties in solving cognitive problems, in general, might also experience higher levels of state neuroticism (e.g., worry, frustration) when confronted with such tasks. For this reason, we will control for individual differences in fluid intelligence.

We recruited a sample of high-performing professionals who were undertaking a range of psychometric assessments as part of a training program run by a major university in Sydney, Australia. This context is conducive to studying the effects of neuroticism on task performance as it represents an assessment setting that is of relevance to examinees, and in that sense can claim more ecological validity than data commonly obtained from student samples.

### 3 Method

#### *3.1 Participants*

In total, 121 adults working in middle-level management roles (aged 24 to 52 years,  $M = 34.2$ ,  $SD = 6.2$ , 42.1% female) at one of four large Australian companies (an

insurance company, a major airline, a national broadcasting company, a financial institution) took part in the study. On average participants had 4.6 years of experience in management and had worked 2 years in their current role within the respective organisation. Of these, 70% had completed a university degree (29% postgraduate; 41% undergraduate); 13% of the participants reported “high school” as their highest level of education. The remaining 17% of participants reported having completed a different degree (“other”) or did not report their level of education (2 participants).

### 3.2 Measures

*Cognitive performance* was measured via 30 items that employ the item paradigm used in the Analysis Synthesis Subtest of the Woodcock-Johnson Psychoeducational Battery-III (Woodcock, McGrew, & Mather, 2001). The items were designed and tested (Bowman, 2006) according to the Relational Complexity Theory (Halford, Wilson, & Phillips, 1998). Each item consists of a number of coloured squares, one of which is empty. Participants are required to determine the colour of the empty square by applying one or more of five given rules. These rules define how combinations of two coloured squares result in the colour of the third (e.g., ‘yellow and black make black’). A multiple choice answer format was used, with the colours yellow, blue, black, and red as the four answer options. The final score represents the percentage of correct answers. The sample estimate of the internal consistency of the Analysis Synthesis Task (AST) was appropriate (Cronbach’s  $\alpha = .80$ ).

*State neuroticism.* The authors compiled a set of seven items assessing cognitive, affective and behavioural states that relate to facets of the neuroticism construct identified within the well-accepted NEO framework (Costa & McCrae, 1992), such as anxiety, angry hostility, depression, self-consciousness and vulnerability (Appendix 1). Participants were asked to have their *current* experience in mind when responding to the respective items. The answer format for all items was a visual analogue scale that required participants to place a marker along a line with the polar ends labelled “not at all” and “extremely”. Responses were translated into a numeric scale from 0 to 100. Internal consistency was high (Cronbach’s  $\alpha = .88$ ).

*Trait neuroticism* was assessed using the International Personality Item Pool (IPIP) version of the NEO inventory (Goldberg et al., 2006; see <http://ipip.ori.org/>). The IPIP NEO inventory is based on the five-factor model of personality (Costa & McCrae, 1992) and contains 50 items assessing five broad dimensions of personality (neuroticism, conscientiousness, agreeableness, openness to experience and extraversion). Participants were instructed to describe themselves as they *generally* are compared to other people of the same sex and roughly the same age. The IPIP NEO used the same answer format as the state neuroticism scale. The polar ends of the statements were labelled “strongly disagree” to “strongly agree”. Internal consistency of the neuroticism subscale was high (Cronbach’s  $\alpha = .88$ ).

*Fluid intelligence* was assessed using the Advanced Progressive Matrices (APM, Raven, Raven & Court, 1998). A computerised version of the APM Set 2 (36 items) was administered in the current study. Items represent a matrix of nine

elements, one of which is missing. Participants are required to induct the underlying rule and to complete the matrix by selecting the appropriate answer option from a set of eight. The performance score represents the percentage of correct responses. Internal consistency was appropriate (Cronbach's  $\alpha = .83$ ).

### *3.3 Design and Procedure*

The study was conducted in three sessions that were between 4 to 6 months apart. All measures were computer administered. In session one, participants filled in the IPIP NEO inventory and a demographic questionnaire. The APM was completed in session two. Finally, the state neuroticism measure followed by the cognitive task (AST) was completed in session three. Participants were assessed in groups of about 12 individuals. All assessments took place in a teaching room that was equipped with computers. Assessments were conducted in accordance to guidelines for psychometric testing (see APA Standards for Educational and Psychological Testing, 1999).

### *3.4 Data analyses*

We used hierarchical regression analysis to test the hypothesis. In Model 1, performance in the cognitive task was regressed on state neuroticism. In Model 2, the non-linear effect of state neuroticism was tested by entering the quadratic term of state neuroticism as an additional predictor in the equation. Subsequently, in order to test whether the effects of neuroticism on performance are due to structural components of neuroticism, the linear and quadratic effect of trait neuroticism on task performance were analysed in Model 3 and Model 4, respectively.

Finally, we re-estimated regression model 2 whilst controlling for trait neuroticism and fluid intelligence (Model 5). This approach allows us to identify the effect of state neuroticism on performance controlled for between-person or structural differences in neuroticism and fluid intelligence. In this sense, it provides an estimate of the within-person (or trait-free) neuroticism-performance effect. Note, the relationship between states can differ in size and direction from the relationship between the related traits (e.g., Nezlek, 2001; Beckmann et al., 2010).

The size of the sample recruited for this study allows the detection of small to medium sized effects ( $f^2 \geq 0.07$ , Cohen, 1988) in a hierarchical regression analysis with 4 predictors with sufficient statistical power ( $1 - \beta \geq .80$ ) at a conventional acceptable type I error level of  $\alpha \leq .05$ .

#### 4 Results

Table 1 shows the means, standard deviations and item-intercorrelations for the study variables. The state neuroticism measure was significantly related to the IPIP NEO neuroticism scale ( $r = .27, p < .01$ ), suggesting that state and trait measures employed in this study relate to the same construct of neuroticism. As expected, performance in the Analysis Synthesis Task (AST) was significantly related to performance in the APM ( $r = .46, p < .01$ ). Inspection of the mean percentages of correct responses revealed that for the current sample the AST was somewhat more difficult (54.87%) than the APM (61.71%), suggesting that the AST is an even more demanding cognitive task. The test for a linear relationship between trait neuroticism and fluid intelligence – as measured by the APM – did not reach statistical significance; however, the size of the observed effect ( $r = -.16$ ) is in line with previous

findings showing a weak negative relationship based on larger samples (see Ackermann & Heggstad, 1997).

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Table 1

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The hierarchical regression analyses revealed: (1) There was no linear effect of state neuroticism on performance in the Analysis Synthesis Task (model 1:  $\beta = -.01$ ,  $t = -0.13$ ,  $p = .89$ ,  $\Delta R^2 = 0.0\%$ ). (2) The quadratic effect of state neuroticism on task performance was significant (Model 2:  $\beta = -.84$ ,  $t = -2.82$ ,  $p < .01$ ,  $\Delta R^2 = 6.6\%$ ). The function of the state neuroticism-performance effect was inverted-U shaped, suggesting that moderate levels of neuroticism experienced in a given task situation are most conducive for performance. (3) Neither the linear effect (Model 3:  $\beta = -.04$ ,  $t = -0.38$ ,  $p = .71$ ,  $\Delta R^2 = 0.1\%$ ) nor the quadratic effect (Model 4:  $\beta = -.10$ ,  $t = -0.27$ ,  $p = .79$ ,  $\Delta R^2 = 0.1\%$ ) of *trait* neuroticism on task performance reached statistical significance. (4) The quadratic effect of state neuroticism on task performance remained significant when controlled for trait neuroticism and fluid intelligence (Model 5:  $\beta = -.64$ ,  $t = -2.34$ ,  $p < .05$ ,  $\Delta R^2 = 3.7\%$ ). Findings of these final analyses (Model 5) are presented in Table 2.

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Table 2

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The quadratic neuroticism-performance effect (controlled for trait neuroticism and fluid intelligence) is displayed in Figure 1. As the turning point of the curve sits



at a neuroticism score of 22.03, the optimum level of state neuroticism in terms of task performance was observed at about half a standard deviation above the sample mean ( $M=17.61$ ,  $SD=13.92$ ). For comparison purposes the non-significant effect of trait neuroticism on task performance (again controlled for fluid intelligence) is also depicted in Figure 1.

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Figure 1

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## 5 Discussion

The aim of this paper was to further investigate the role of neuroticism as a predictor of cognitive performance. To our knowledge there is no other study that included both trait and state neuroticism as predictors of cognitive performance. The findings support our hypothesis: The level of neuroticism experienced before undertaking a cognitive task was curvilinearly related to an individual's performance on the task, with low and high levels of neuroticism being less conducive to task performance. Importantly, we also found that (1) trait neuroticism was not a predictor of task performance (neither linearly nor non-linearly), and (2) the observed state neuroticism-performance effect remained significant after controlling for between-person differences in trait neuroticism and fluid intelligence.

The notion of a curvilinear relationship between neuroticism and cognitive performance has been discussed previously on a conceptual level (Eysenck, & White, 1964; Brand et al., 1994). The reported study contributes with empirical evidence to this discussion. Previous work has analysed the neuroticism-performance

relationship from a structural or trait perspective with overall discouraging results. Although Lynn and Gordon (1961) reported a significant quadratic effect in an early study, more recent work has failed to replicate this finding in larger samples (e.g.,  $N = 71887$ , Reeve et al., 2006). The present study also confirms the reported non-existence of a quadratic effect of trait neuroticism on task performance. A possible post hoc explanation for the inconsistency in the findings is that in the initial study (Lynn & Gordon, 1961) trait neuroticism was measured directly before participants underwent cognitive testing. This could have caused that the trait neuroticism measure also captured some of the individual experience of neuroticism (i.e. state neuroticism) when facing upcoming testing. In later studies personality trait and cognitive performance measures were not always linked as closely in time (e.g. Reeve, et al., 2006; Austin et al., 1997). In the present study we were able to assess trait neuroticism several months prior to cognitive task performance, which helps preventing such possible confounding.

Our findings are in line with emerging evidence of a performance *facilitating* effect of neuroticism in some circumstances. Van Doorn and Lang (2010) as well as Smillie et al. (2006) discussed that trait neurotics tend to benefit from demanding task conditions. This has been explained in terms of induced changes in the allocation of mental resources. Demanding tasks force neurotic individuals to shift their attention towards the task and away from task irrelevant, negative cognitive content. In line with this argument, neurotic individuals performed relatively better when tasks became more difficult and required effort (van Doorn & Lang, 2010; Smillie et al., 2006, Study 2). Neurotic individuals also outperformed their more emotionally stable

counterparts under such conditions (Smillie et al., 2006, Study 1 and 2). Perkins and Corr (2005) found a positive correlation of worrying, the cognitive component of anxiety, and performance at work. This relationship, however, was not apparent in low ability individuals. Interestingly, these findings seem to stand in contrast to expectations derived from arousal theory, which would expect more neurotic, anxious, aroused individuals to underperform on more difficult tasks (Mohan & Kumar, 1979).

Our findings extend this line of research by further specifying the effect of neuroticism, as experienced in a given situation, on task performance. More specifically, we found that increases in state neuroticism had an optimising effect on performance on tasks that were of moderate difficulty. However, for individuals with state neuroticism scores more than half a standard deviation above the sample mean this effect reversed. The correlation between neuroticism and performance was positive for individuals that scored below this score ( $r = .21, p = .05, N = 81$ ), suggesting a small positive effect.

One potential limitation of the study presented is that, based on the methodology applied, we cannot conclusively infer a causal link between state neuroticism and task performance. This would have required an experimental manipulation of levels of state neuroticism. However, the causal interpretation that we imply rests on the fact that state neuroticism was assessed prior to task performance. As an interesting extension of the current study, future research could employ a repeated measures approach, in which state neuroticism is manipulated within a person. In addition to potentially providing a more conclusive test of the

causal nature of state neuroticism, such a within-person approach would also allow more accurate modelling of the dynamic within-person relationship between repeated measures of both state neuroticism and cognitive performance on tasks varying in difficulty. An advantage of our methodology was that we studied the state neuroticism effect while controlling for between-person differences in trait neuroticism and fluid intelligence, which enabled us to identify the net effect of state neuroticism. The fact that we were able to recruit a sample of high-performing adults for whom the cognitive task represented a “true” test situation contrasts with the prevalent use of (psychology) undergraduates participating as part of their course work. We believe that this lends additional credit to our findings.

The finding that state and trait neuroticism are differentially related to cognitive performance highlights the necessity of a conceptual as well operational distinction in research on the dynamics of personality. Such a distinction between structural and experiential aspects of personality is particularly relevant for research concerned with personality change. Trait approaches have inherently focused on the stable aspects of personality. Consequently, there have been barely any applications designed to develop personality in a way that facilitates performance. It is likely that experiential aspects of personality are more amenable to intervention.

We draw two main conclusions. First, as a psychological state is more proximal to the task it is the more appropriate predictor of cognitive performance. Whilst, by definition, trait neurotics are expected to experience higher levels of state neuroticism (i.e. negative affect, anxiety, arousal) in a given situation, in the current study trait neuroticism was unrelated to performance outcomes. Second,

experiencing neurotic states does not necessarily have negative implications for performance. In fact, it can be advantageous to feel slightly neurotic when undertaking a complex cognitive task.

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## 7 Figure Captions

Figure 1: Relationship between neuroticism and task performance controlled for fluid intelligence

## 8 APPENDIX

## State neuroticism items

- How tense are you feeling right now? (anxiety)
- How calm are you feeling right now? (anxiety, reverse-coded)
- How frustrated are you feeling right now? (angry hostility)
- How sad are you feeling right now? (depression)
- How self-conscious are you feeling right now? (self-consciousness)
- How dissatisfied with yourself are you feeling right now? (self-consciousness)
- How stressed are you feeling right now? (vulnerability)

Table 1: Descriptive Statistics for Study Variables (N = 113-121)

Variables	Mean	SD	1.	2.	3.	4.	5.	6.	7.	8.
1. Age	34.22	6.20								
2. Gender <sup>1</sup>	-	-	-.15 <sup>+</sup>							
3. Years of management experience	4.64	4.28	.54 <sup>**</sup>	-.18 <sup>+</sup>						
4. Years in current job	1.97	2.11	.24 <sup>**</sup>	-.03 <sup>+</sup>	.12					
5. Fluid intelligence	61.71	15.16	-.16	-.11 <sup>+</sup>	-.18	-.09	(.83)			
6. Task performance	54.87	16.72	-.05	-.07 <sup>+</sup>	-.11	.03	.46 <sup>**</sup>	(.80)		
7. State neuroticism	17.61	13.92	-.09	-.04 <sup>+</sup>	-.06	.03	.10	-.01	(.88)	
8. Trait neuroticism	31.55	14.96	-.13	.14 <sup>+</sup>	-.19 <sup>*</sup>	.01	-.16	-.04	.27 <sup>**</sup>	(.88)

Note: <sup>1</sup>Gender was coded: 0=male (N=70), 1=female (N=51), <sup>+</sup>represent point biserial correlations; <sup>\*\*</sup>p < .01, <sup>\*</sup>p < .05; Coefficients in brackets represent Cronbach's  $\alpha$

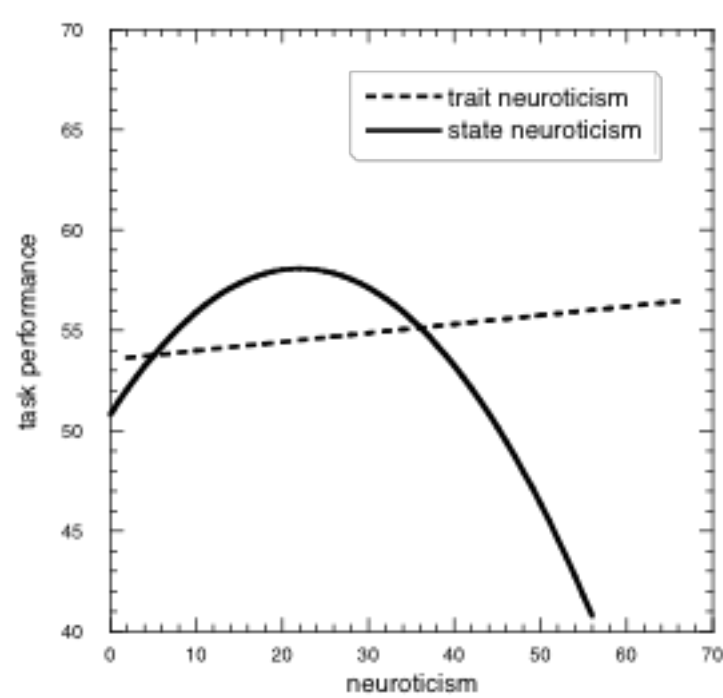
Table 2

Table 2: Hierarchical Regression of Task Performance on Fluid Intelligence, Trait Neuroticism, State Neuroticism and the Quadratic Effect of State Neuroticism

<i>Model</i>	<i>Variable</i>	$\beta$	<i>t</i>	$\Delta R^2$ (%)
Model 5.1	Fluid intelligence	.47**	5.51	0.1
	Trait neuroticism	.04	0.46	
Model 5.2	Fluid intelligence	.48**	5.57	0.5
	Trait neuroticism	.06	0.66	
	State neuroticism	-.07	-0.83	
Model 5.3	Fluid intelligence	.45**	5.25	3.7
	Trait neuroticism	.03	0.39	
	State neuroticism	.54	1.96	
	Quadratic effect of state neuroticism	-.64*	-2.34	

Note:  $N = 116$ ; \*\* $p < .01$ , \* $p < .05$

Figure 1



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